per hour per tractor-scraper when the round-trip distance is reduced from 600 to 400 feet and only 8 cubic yards per hour when the round trip distance is reduced from 1,200 to 1,000 feet.

The conclusions reached during the investigation are summarized as follows:

1. Light earth-moving equipment is particularly adapted to hillside and hilltop stripping in hilly and mountainous areas because of the mobility of these machines. This type of equipment also has the advantage of being able to move itself to the mine site. Bulldozers and tractor-scrapers build roads to the mine, and these roads are used later in the transportation of the coal produced from the mine and material and supplies to the mine.

2. Tractor-scraper operation should be planned so that the round-trip haul is held to a minimum. The most efficient length of round-trip haul (fig. 24) appears to be 800 feet or less.

3. The length of cut that should be made by tractor-scrapers on the high wall for efficient operation depends on the compactness of the overburden. Scrapers can make deeper cuts in soft than in hard material, and the length of cut should be the shortest distance required to load the scraper to capacity without stalling the pulling or pushing tractors. Therefore, the shortest round-trip haul at any strip mine depends on the length of cut and the distance from the cut to the spoil pile.

4. Tractor-scrapers often are used as auxiliaries to stripping shovels. The overburden beyond the limits of the stripping shovels is moved by tractor-scrapers, and this practice enables the shovels to uncover coal that otherwise might be lost.

5. The law of some States requires restoration of the surface after the coal has been mined by stripping. Bulldozers, tractor-scrapers, and dump wagons are adapted to this work, because spoil piles can be shaped as stripping progresses.

6. Tractor-scrapers do not operate efficiently when digging wet, sticky material and are not suitable for digging rock.

Mining in Belgium and Germany

During the war, as rapidly as the Allied Forces regained European territory, it was necessary to see that the liberated people were supplied with fuel as well as other things. The conditions prevailing in Europe and the methods used to provide as much coal from local sources as possible was of a great deal of interest to the American people. Dr. Louis C. McCabe, formerly a colonel attached to SHAEF, was in charge of coal mining and distribution in Belgium and later in the Allied occupation zone of Germany as well. The activities in Belgium immediately after liberation and the entire Allied zone following the defeat of Germany has been discussed many times, but has appeared

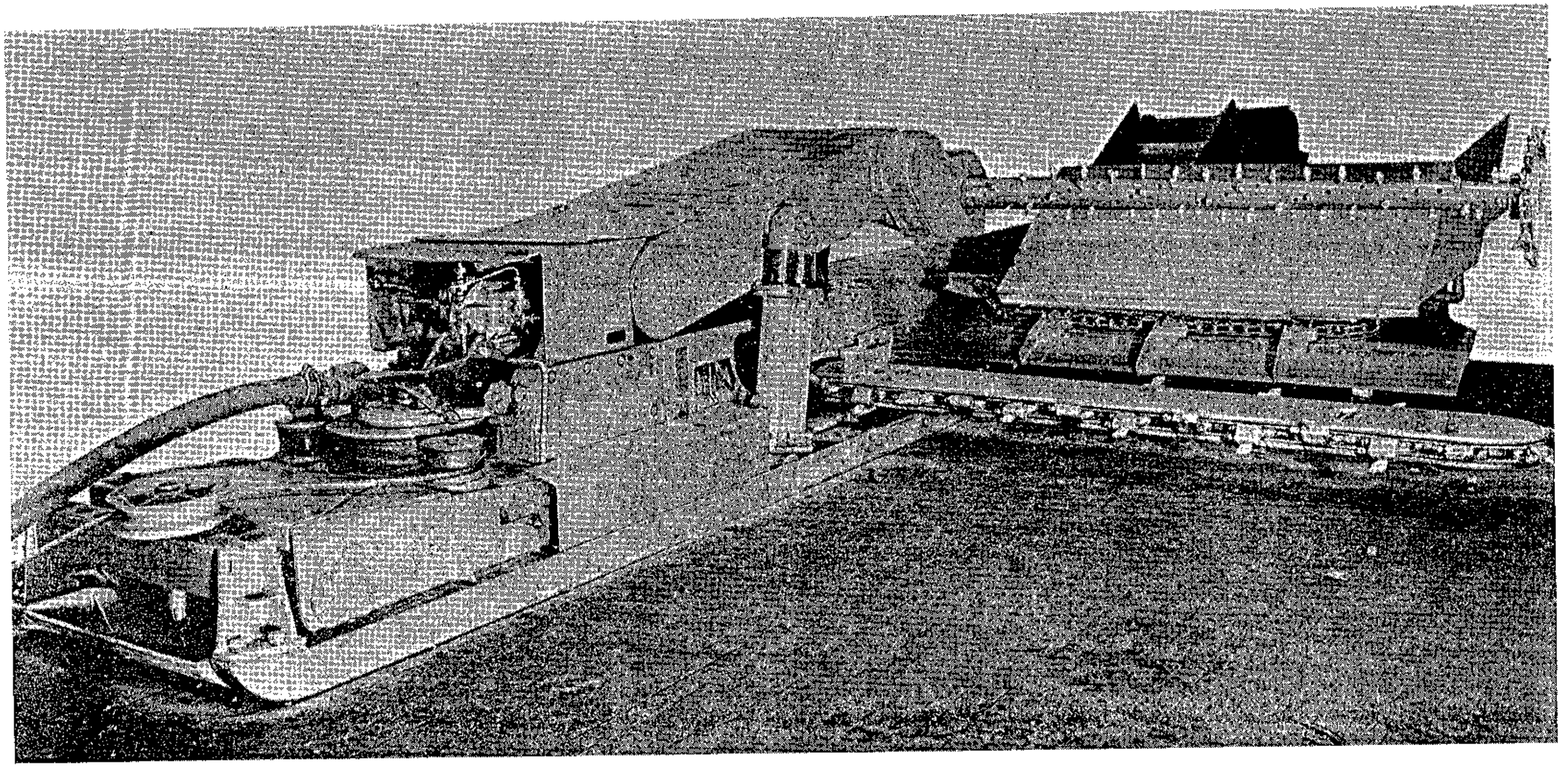

Figure 25. - Eickhoff Schrämlader (coal cutting and loading machine).

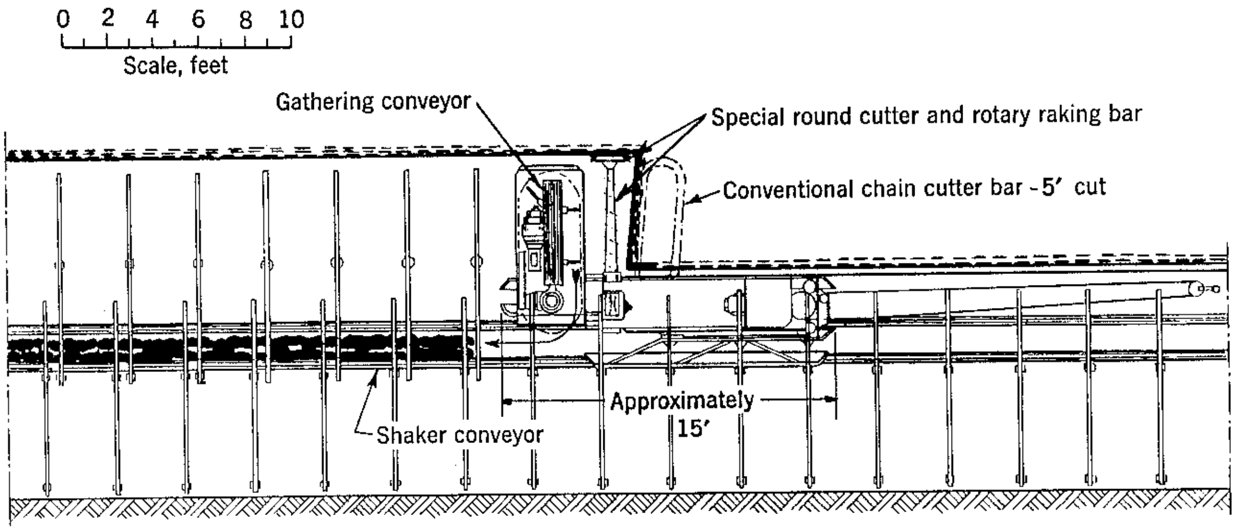

Figure 26. - Eickhoff Schrämlader (coal cutting and loading machine), showing arrangement of gathering conveyor loading directly into shaker conveyor.

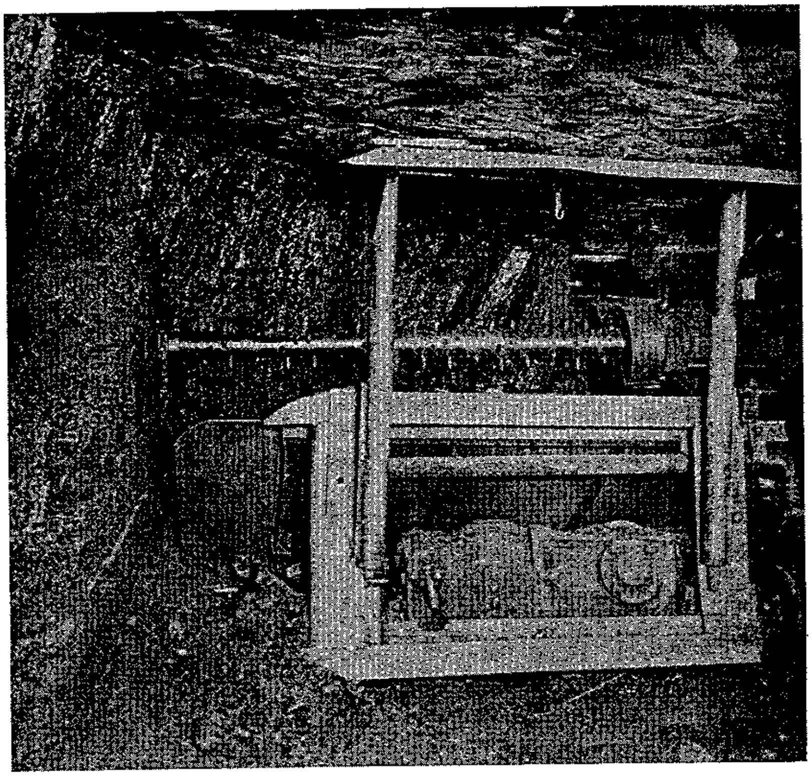

Figure 27. - Machine in operation, showing cut made by disk at end of raking bar.

in published form only once.[17] Methods used to increase coal production to meet military and essential civilian needs and the allocation of mined coal, together with a summary of the amount of coal produced in Germany over a several-year period, were reported.

Eickhoff Schrämlader

The mining industry in the United States is interested in new types of mining machinery adaptable to mechanized mining in this country. Detailed German drawings showing the design of a longwall coal cutting and loading machine, developed by Eickhoff Maschinenfabrek, Bochum, Germany, and instructions for its operation, were sent to the Bureau of Mines from Germany by the Solid Fuels Section, SHAEF. The development and testing of this machine in Germany are supposed to have taken place during the latter part of 1941 and early 1942. An engineering description of the machine was published.[18]

The Eickhoff cutting and loading machine, shown in figure 25, can be used where underground conditions are favorable for longwall mining. It is not suitable for use in room-and-pillar work. The basic principle of the machine is a typical longwall jackknife coal-cutting arm for cutting a bottom kerf approximately 5 feet deep. An auxiliary cutting unit is mounted on top of the chain cutter car. This auxiliary cutting unit consists of a round raking bar mounted in a substantial supporting arm. This arm is hinged and is moved up and down by hydraulic jacks so as to place the raking bar in any position between the chain cutter bar and the top of the coal. This raking bar dislodges the coal, and the broken coal falls onto a horizontal flight conveyor. This conveyor delivers the coal to a longwall shaker conveyor in the room which transports the coal to the loading point on the entry. (See figs. 26 and 27.)

The machine is reported to have been installed and used in the Jacobi coal mine in Germany and produced the following tonnages during 1942:

1942	Tons
August	10,433
September	10,750
October	12,267

No information is available of the man-hours required to operate the machine, but evidently considerable dead work is required to move it from one working face to another prepared longwall face and then to place it in operation.

This type of machine could be manufactured in the United States if the coal-mining industry desires to experiment with it in longwall mining. Some

17/ McCabe, Louis C., Belgian and German Coal Mining During the European Campaign: Proc. Illinois Min. Inst., 1946, pp. 53-63.
18/ Arentzen, Einar M., Description of the Eickhoff Schrämlader, Longwall Coal Cutting and Loading Machine: Bureau of Mines Inf. Circ. 7390, 1946, 5 pp.

of the cutting elements of the machine might be combined with mechanical loaders now used in this country and result in more flexible operation than the use of the conveyor arrangement of the Eickhoff machine.

Bureau of Mines Scraper-Shaker Loader

A scraper-shaker loader was designed and built by the Bureau to solve the problem of transportation delays in mechanizing development work in thin, steeply pitching anthracite beds. It consists of a standard scraper loading slide, having a hoe-type scoop which discharges into the drive pan of a shaker conveyor. The drive pan is permanently installed as a part of the loading slide and actuated by a standard shaker-conveyor drive permanently mounted upon the truck of the scraper-loading slide. Both scraper and shaker are compressed-air-powered, since there is no electrical distribution system underground in the condition for which it was built. Animal haulage is used exclusively in this mine. By extending the shaker-conveyor trough line, which is suspended from the roof at greater than car height, enough mine cars can be placed before loading begins so that one full face cut can be loaded mechanically without excessive transportation delays attributed to animal haulage.

Preliminary tests of this loading machine have been completed, and its practicability has been proved. Using it a rate of advance double that of single-car scraper loading was shown to be attainable, with a rate of advance six times that obtained by hand methods. The machine has been removed in order to incorporate improvements in design which the experimental work indicated.

Eickhoff Shearing Machine

An Eickhoff shearing machine, model DEK, of German origin was imported for test purposes in productive mining of thin, steeply pitching beds of anthracite. This machine, which weighs only 1,500 pounds complete with caterpillar mount, makes a vertical shear cut 3 inches wide and 5-1/2 feet deep. Driven by a compressed-air motor of 9-horsepower rating, the machine developed 15.3 horsepower under Bureau tests, although 6 horsepower was found to be sufficient for cutting anthracite with it. The caterpillar mount will be replaced by a skid frame for driving 30° slant chutes in a bed pitching 85° under a new plan being developed for mechanizing heavy-pitch work.

Korfmann Universal Shearing Machine, Model SK 20

A Korfmann universal shearing machine, model SK 20, was imported from Germany to be tested in the anthracite region of Pennsylvania. This machine, weighing approximately 2 tons, is driven by a compressed-air motor rated at 20 horsepower. Within the practical operating ranges, Bureau tests showed a maximum output of 16.1 horsepower, which is more than twice the power required to cut anthracite. The universal feature permits unlimited multi-directional cutting by revolving the machine head, through 360°, to the position desired. This machine is mounted on a car-wheel truck and will be remounted on caterpillars for driving a trackless gangway 1,600 feet in length.

German Coal Planer

The rigid-blade coal planer[19] was fully developed in wartime Germany; but in that form can only be used for mining friable coal beds or on longwall faces where closely controlled roof pressure is used to break up the solid coal face sufficiently in advance of the mining. The vibrating-blade planer, intended for use in harder coals, had not been fully developed by the war's end. The Bureau has undertaken the design, manufacture, and development of such a vibrating-blade planer for tests in anthracite mines. Investigations showed pneumatic hammers to be more suitable than mechanical or electrical devices for the vibrating action, and four special hammers for use in the Bureau's planer are now in the process of manufacture. Intended for trial in thin, flat, virgin beds of the Wyoming region, successful application of the planer principle to anthracite will open a way to mine the 50-foot heavily pitching beds of the Southern field mechanically. It was found that the best conventional mining practice in the German Ruhr district was improved more than threefold by introduction of the coal planer.

Anthracite Flood Prevention

The flooding of active and abandoned anthracite mines in certain areas of Pennsylvania is a constant menace to life and property, threatening to curtail the life of the anthracite industry and to decrease the present production of anthracite. The problem of flooding was investigated with consideration given to three main sources, which are: (1) Main- and side-stream leakage, (2) general surface leakage, and (3) barrier-pillar seapage. Billions of gallons of impounded water threatening active workings have been located and shown on maps.[20] The general topography in the anthracite region is such that water from the steep mountains tends to collect in almost every man-made opening, whether it is a stripping or underground mining operation. Some measures have already been taken in the region to divert water. However, there remain many properties separated from water pools by barrier pillars which probably are not strong enough to maintain the head of water against them. In other instances, particularly in the Susquehanna Valley in the Northern field, the water channels underneath present river beds are so close to the coal measures that unless special precautions are taken the water may break through, causing an enormous loss of coal. The details of the solution of the flooding problem cannot be postulated until a comprehensive study of the entire mine water problem has been made.

Acid Mine Water from Anthracite Mines

The mine-drainage systems in the anthracite region handle over 200 billion gallons of water annually, of which 150 billion gallons is pumped to the surface. Much of this water is being utilized for breaker use, dust-control

[19] Buch, John W., Design and Operation of the Coal Planer, Ruhr District, Germany: Bureau of Mines Inf. Circ. 7377, 1946, 20 pp.

[20] Ash, S. H., and Westfield, James, Flood-Prevention Projects at Pennsylvania Anthracite Mines: Bureau of Mines Rept. of Investigations 3868, 1946, 25 pp.

installations, and hydraulic back filling; as well as to combat mine fires and aid in the transportation of anthracite in gently dipping places where sheet iron is used.21/ It is estimated that 1,100 gallons of mine water is utilized in preparing each ton of anthracite mined.

Much of the mine water used is highly acid, and, unless treated to reduce the acidity, the replacement and labor costs required to maintain coal preparation at desired capacity are exorbitant.

The treatment of mine water for washery use by lime reduces maintenance costs considerably.

The first installation for lime treatment of mine water used for preparing anthracite was put into operation in 1932. The four types of installations used are the screw feeder, the vibrating feeder, the disk feeder, and tanks in which lime and water are mixed.

At present, hydrated lime is the only kind of lime used in the anthracite region to treat acid water.

The advantages of treating acid mine water with lime are shown by comparing the cost of breaker materials before and after treatment and by the favorable statements of individuals in charge of the lime-treatment installations.

Anthracite-Mine Dust Problems

Studies have been conducted by the Bureau of Mines in the anthracite region of Pennsylvania, in cooperation with several large mining companies, to develop methods for eliminating or reducing the dissemination of dust into the air by various mining practices. No single method of control is applicable to all dusty operations, and several methods have been practiced with considerable success. Preventing the dissemination of dust by undercutting machines, pneumatic drills, blasting, loading, and transportation of coal is discussed. The methods presented are practical and were successful in markedly reducing the dust concentration in the breathing zone of the worker. Such dust-control procedures not only reduce possibility of injury to health but also increase the efficiency and morale of the worker.22/

Back Filling in Anthracite Mines

Mine subsidence causes a great deal of damage to surface ground and structures and also endangers mine workings. The Pennsylvania anthracite region

21/ Johnson, Leland H., Treatment of Acid Mine Water for Breaker Use in the Anthracite Region of Pennsylvania: Bureau of Mines Inf. Circ. 7382, 1947, 14 pp.

22/ Johnson, Leland H., Dust Problems in the Mines of the Pennsylvania Anthracite Region: Bureau of Mines Tech. Paper 704, 1947, 34 pp.